RP 208 Shaft Current Management

The following recommended practice (RP) is subject to the disclaimer at the front of this manual. It is important that users read the disclaimer before considering adoption of any portion of this recommended practice.

This recommended practice was prepared by a committee of the AWEA Operations and Maintenance (O&M) Committee.

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Purpose and Scope

The scope of "Shaft Current Management" addresses the common maintenance issues related to the grounding systems for generator and drive train shafts in various wind turbine designs. It is not machine specific and some adaptation may be required based on specific designs.

Introduction

A wind turbine generator shaft is usually protected by a grounding system to prevent currents from passing onto the generator and/or drive train bearings. The use of carbon brushes contacting the shaft rotating area and tied into the unit's grounding is the most popular way of managing unwanted shaft currents. These brushes are wear items and should be included in any regularly scheduled maintenance inspection or process. The normal recommendation is to inspect and clean the brush and assembly at least bi-annually, but longer maintenance cycles may be possible with improved materials and designs. Brush life is affected by carbon grade, shaft speed, ambient temperature and humidity, and other operating environmental conditions. During maintenance, a careful visual inspection should be performed and any abnormal conditions should be documented, preferably including photographs.

Understanding the Need for Shaft Grounding

Shaft voltages can be caused by:

- Asymmetry in the magnetic circuit of rotating electrical machines
- Build-up of static charges within the shaft
- Capacitative coupling of voltages into static exciting systems

Understanding the Need for Shaft Grounding
(continued)

If current passes via the bearings of an electrical machine, high current densities may occur on the small contact points within the bearing, which can result in a local melting of the metal surfaces. The consequence is the formation of small craters and serrations. This typically increases the internal friction of the bearing and worsens over time causing increased temperature, contaminated lubrication, and ultimately bearing failure.

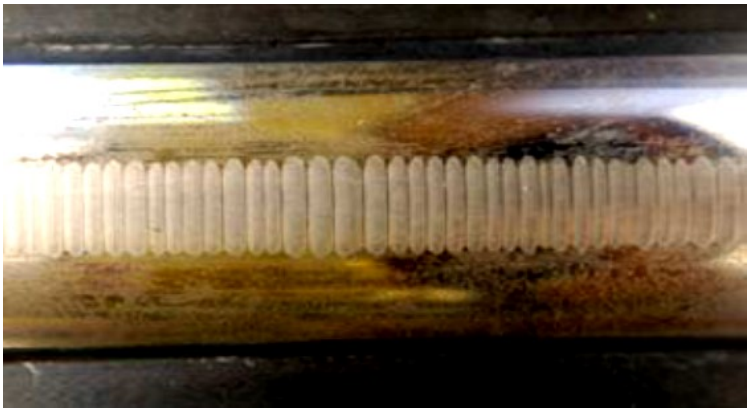

Figure A: Ripple formation on bearing race caused by voltage passing through bearing (fluting)

Electrical insulation of the bearings is a common practice but is not always sufficient. Shaft grounding with carbon brushes helps to protect components by grounding out the majority of the voltage/current before making contact. This grounding is typically achieved by two brushes being mounted in a 90° angle on the shaft as seen in the Figures B and C below. Varying grades may be recommended based on the operating conditions and the turbine manufacturer, or a trusted carbon brush manufacturer can help with choosing the proper grade for the conditions.

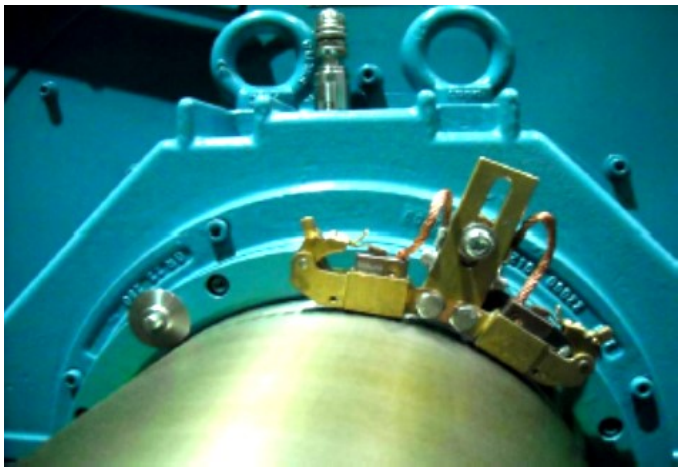

Figure B: Example of Main Shaft Grounding

Understanding the Need for Shaft Grounding
(continued)

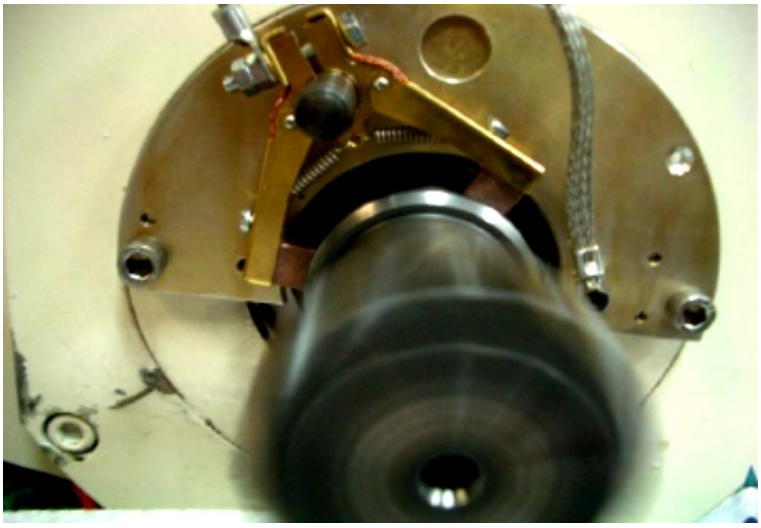

Figure C: Example of Generator Shaft Grounding

Shaft Grounding Maintenance Procedures

1. Inspecting The Assembly

Remove the shaft cover if one exists. View the general condition of the assembly. Note any build-up of residue, leaking gaskets, broken or missing components, etc. It is always good to document the “as found” condition of the brush and assembly with an image.

1.1. Brushes

1.1.1. Removal

To remove the brush from most designs, pull back the spring loaded holder arm and loosen any connections to the holder assembly. Other styles of tension devices may be in use. Consult the manufacturer’s specifications for a specific generator design. Pull the brush out of its holder by its cables without disconnecting it. Note the orientation of the brush to the holder to ensure the brush will properly be reinstalled if it is not to be replaced.

1.1.2. Brush Body

Inspect the brush for minimum length requirement, any unusual wear-marks, and free movement of the brush in the holder noting any restriction that maybe a sign of material swelling.

NOTE: This should also be a regular test for lightning protection brushes.

Inspect for chipping or cracking. Assure that the terminals are secure and that shunts, micro switch tabs, etc., and rivet connection, if applicable, are in good working order and properly mounted and connected.

1.1.3. Shunt Wires

Discolored shunt wires can indicate overheating or extreme current discharges. It is recommended to replace the complete brush set, because single brushes can already be damaged. If the shunts are damaged or frayed by vibration or mechanical problems, they should also be replaced and the condition corrected. Note any abnormal wear indicators. Verify terminal connections are secure on all brushes. Additionally, shunt wires should still be pliable when moving. If the shunt wires are rigid, they are susceptible to damage causing reduction in conductivity and the brushes should be changed.

1.1.4. Brush Surface

Rough brush face surfaces may be caused by brush sparking from electrical or mechanical problems.

Rule of thumb: If one of the brushes has to be replaced and the set is worn more than 25%, all the brushes should be replaced. If all brushes are to be replaced, disconnect them and remove them from the assembly. Loosen the terminal bolts until the brush terminal can be slid out from under it. If possible, do not fully remove the bolt to avoid dropping it and other hardware into the assembly.

1.2. Brush Holder

1.2.1. Holder Box

Inspect entire holder for any indications of arching or burning damage. Verify that all hardware and electrical connections are secure. Note any abnormal wear indicators.

1.2.2. Springs

Inspect tension devices for any indications of arching, burning or discoloration. The spring force should be checked every year with an appropriate spring scale device and springs should be replaced every 3 to 5 years depending on type of application. Springs with a deviation of more than 10% from the set value should be replaced.

1.2.3. Holder Distance

For a safe guidance of the brushes in the brush holder it is normally suggested that the distance between holder and shaft surface is no more than 3 mm (0.125”).

1.3. Counter Surface

Inspect the shaft surface where the brush makes contact. There should be a film (or patina) of on the shaft. **LEAVE THE FILM AS IS!** This helps with the wear and connectivity of the brush to shaft surface. If oil or grease comes into contact with the counter surface, an insulating film can be formed which hampers the current transfer. Increased brush wear could be the consequence. The brushes are porous and, in case of oil contamination, all brushes should be replaced after the shaft surface is cleaned.

2. Cleaning and Reassembly

2.1. Cleaning the Shaft Surface

Typically the generator shaft is a clean area of a generator, but carbon dust may build up over time in this area. For these cleaning procedures, it is suggested that appropriate personal protection devices be worn, including a dust mask.

Use a small vacuum, preferably with a HEPA type filtration system, and a synthetic brush to remove all accumulated dust and other contaminants from the shaft, the brush holder assemblies, and any areas where the dust may have collected below the shaft. Contact cleaner or other solvents should not be used directly on the brushes or the shaft surface. If it is necessary to use a solvent, spray the solvent on a disposable towel or cloth and use the cloth to wipe the solvent on the unclean area. Do not use solvents on carbon brushes because they could affect the carbon material. The surface film (or patina) should not be cleaned with a solvent. Always clean from the top down to avoid re-contaminating components.

2.2. Installing Brushes

To install new brushes or to reinstall brushes after inspection, insert the brush into the holder ensuring the proper orientation then affix the brush back to its operating position. Connect new brushes and check that the connection is tight and the terminal is located correctly under the spring washer. As a final check to assure that the brush is free to move up and down in the brush holder and that the spring is correctly fitted, pull on the brush leads and lift the brush approximately 12 mm (0.5”) and then lower it back onto the shaft a few times. Assure that the brushes are oriented 90° to the shaft and that as much surface as possible is in contact with the shaft surface to avoid premature wear.

2.3. Seating New Brushes

In the event new brushes are manufactured with a bottom radius, seating may be needed to ensure the proper electrical continuity.

Garnet paper or any non-metal bearing abrasive paper is recommended, and cloth backed abrasives are often easier to use in many circumstances. The abrasive size should be 80 to 120 grit. Fine sandpaper, such as 400 grit, will easily fill with carbon making the sanding process more difficult. It is important not to leave abrasive particles under the brushes when completed as these could damage the counter surface.

Seat one brush at a time while all the other brushes are still connected but out of their holders.

Lift the brush by its shunts and slide a strip of the abrasive cloth under it with the abrasive side of the paper facing the brush. Lower the brush down onto the abrasive cloth and place the spring in its normal engaged position. The spring should apply the pressure to the brush. Slide the garnet paper back and forth under the brush in line with the brush path. After several of passes back and forth, remove the brush from its holder and check the face of the brush. The seating is complete when at least 80% of the brush face is abraded. Vacuum out all of the accumulated carbon dust and sanding debris and reinstall the brush

Once properly assembled, assure that all bolts are tightened and the brushes are properly connected.

2.3. Seating New Brushes
(continued)

As a final check that the brush is free to move up and down in the brush holder and that the spring is correctly fitted, pull on the brush leads and lift the brush approximately 12 mm (0.500”) then lower it back onto the shaft a few times.

Also, make sure that all tools and cleaning materials are removed from the area and that any cover gaskets are functioning properly before replacing the cover, if applicable.

Summary

This recommended practice is designed to identify basic procedures and techniques for maintaining the collector ring assemblies in double fed induction generators. Careful cleaning, maintenance, and proper brush replacement, when required, will assure long, trouble free service life for these critical components.

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Chapter 3 Rotor and Blades

Operations and Maintenance
Recommended Practices

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